DOCUMENT RESUME

ED 423 839 IR 019 060

AUTHOR	Hill, Janette R.; Land, Susan M.
TITLE	Open-Ended Learning Environments: A Theoretical Framework and Model for Design.
PUB DATE	1998-02-00
NOTE	13p.; In: Proceedings of Selected Research and Development Presentations at the National Convention of the Association for Educational Communications and Technology (AECT) Sponsored by the Research and Theory Division (20th, St. Louis, MO, February 18-22, 1998); see IR 019 040.
PUB TYPE	Reports - Descriptive (141) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Computer Uses in Education; Constructivism (Learning); Educational Environment; Educational Technology; Guidelines; *Instructional Design; *Instructional Development; *Learner Controlled Instruction; Models; *Open Education; Student Centered Curriculum; Student Role; Teacher Role
IDENTIFIERS	*Learning Environments; *Open Ended Learning Environments; Problem Based Learning; Scaffolding

ABSTRACT

This paper presents a framework and model for design of open-ended learning environments (OELEs). First, an overview is presented that addresses key characteristics of OELEs, including: use of meaningful, complex contexts; provision of tools and resources; learner reflection and self-monitoring; and social, material, or technological scaffolding. Next, the following assumptions associated with the design of OELEs are discussed: understanding is best achieved when situated in relevant contexts; learners must take more responsibility for monitoring and reflecting upon the learning process; understanding is best supported when learners connect personal experiences with formal concepts; and learning is a byproduct of progressive negotiation and interpretation of meanings. Following establishment of a framework for understanding the challenges and opportunities afforded by OELEs, a theoretical model for designing OELEs is introduced. The following phases and related considerations are described: (1) analysis, including environmental and participant characteristics; (2) design, including objectives, instructional domains, instructional content, means of instruction, and evaluation methods; (3) development and implementation, including resources, and on-going effort; (4) evaluation; and (5) maintenance. Finally, guidelines are offered to assist in use of the model for design and development of learning environments based on open-ended constructs. (Contains 48 references.) (AEF)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

Open-Ended Learning Environments: A Theoretical Framework and Model for Design

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☐ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Janette R. Hill
University of Northern Colorado

Susan M. Land
Pennsylvania State University

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
M. Simonson
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)"

ED 423 839

Abstract

One form of learning environments that continue to draw attention and interest are those open-ended in nature. Open-ended learning environments (OELEs) are learner-centered; the instructor plays the role of a facilitator rather than that of the focal point for learning. While the opportunities afforded by OELEs for enhancing learning are substantial, considerable challenges arise in their creation and implementation. The purpose of this paper is to present a framework and model for the design of OELEs. We first present an overview of OELEs. Next, assumptions and issues associated with the design of OELEs are discussed. Following the establishment of a framework for understanding the challenges and opportunities afforded by OELEs, a theoretical model for designing OELEs is introduced. Finally, guidelines will be offered to assist in the use of the model for the design and development of learning environments based on open-ended constructs.

One form of learning environments that continue to draw attention and interest are those open-ended in nature. Open-ended learning environments (OELEs) afford and support exploration and experimentation; problem solving, critical thinking, and multiple perspectives are essential processes in these environments [for a more complete description of OELEs, see Hannafin, Hall, Land & Hill, 1994]. OELEs are learner-centered; the instructor plays the role of a facilitator rather than that of the focal point for learning. Individual experiences and contexts are emphasized as learners cultivate cognitive processes to support understanding in OELEs. The development of strategies and processes are focal points for demonstrating growth in understanding (Land & Hill, 1997; Papert, 1993).

While the opportunities afforded by OELEs for enhancing learning are substantial, considerable challenges arise in their creation and implementation. OELEs come in many varieties (simplistic and focused; complicated and limitless) and can be manifested in several settings (face-to-face instruction, distance learning environments, computer assisted instruction, etc.). Like most learning situations, well-designed and developed OELEs have the ability to empower, liberate, and expand the orientations of their participants [for related discussions on the value of sound instructional design in other learning situations, see Moore & Kearsley (1996); Willis (1993)]. At the same time, OELEs are demanding, and can be disorienting, even unsettling, for those engaged in these environments. The learners, as well as the instructor, are placed in roles not traditionally held in formal learning environments; furthermore, the processes associated with these environments (problem solving, critical thinking, etc.) are ones which demand considerable work by all participants (Hannafin, Hill, & Land, 1997). Designing and developing learning environments that empower the user, are intuitive and self-evident, and inclusive in orientation is a formidable challenge (Norman, 1988).

The purpose of this paper is to present a framework and model for the design of OELEs. We first present an overview of OELEs. Next, assumptions and issues associated with the design of OELEs are discussed. Following the establishment of a framework for understanding the challenges and opportunities afforded by OELEs, a theoretical model for designing OELEs is introduced. Finally, guidelines will be offered to assist in the use of the model for the design and development of learning environments based on open-ended constructs.

IR019060

BEST COPY AVAILABLE

Overview of OELEs

OELEs coordinate application of a variety of tools and resources for use in addressing situated, authentic problems (Hannafin, Hill, & Land, 1997). Technology is often used as a mediator of the process, providing learners with electronic means to search vast databases of resources and manipulate variables and concepts. Yet, fundamentally, OELEs support student-centered understanding -- the learner is at the center of the environments both in terms of decisions for using the available resources and as the party with the primary responsibility for learning. As such, OELEs have relied heavily upon theoretical views from constructivists, who assert that understanding is best achieved when it is individually driven by, or constructed by, the learner (Jonassen, 1991; Phillips, 1995). In essence, OELEs support learner-centered construction with opportunities to relate new knowledge to personal experiences from a problem-based, activity-intensive orientation. Technologically-based tools and resources are used as means to support the constructive process.

OELEs provide interactive, complimentary activities that revolve around problem-based contexts and support individual sense-making processes (Hannafin, 1992; Hannafin, et al., 1997). OELEs are comprised of several key characteristics that enable them to support divergent student needs and establish the conditions for enriching thinking. Several of these key characteristics include the following: (1) use of meaningful, complex contexts (2) provision of tools and resources; (3) learner reflection and self-monitoring; and (4) social, material, or technological scaffolding.

Use of Meaningful, Complex Contexts

One common characteristic of OELEs is the use of broad, problem-based contexts that form the adhesive for all conceptual activity. Problem-based contexts serve three primary purposes: (1) to orient learners to the activity; (2) to provide an guide for applying what is known and evaluating what is not known; and (3) to assist learners in connecting formal concepts to everyday applications of them.

Scenarios or cases, for instance, are often used to guide learners in exploring the complexities of a topic. Such contexts often focus on everyday problems (e.g., environmental pollution for studying chemistry concepts; swimming pools for studying buoyancy and water displacement; corporate cases to study management principles; real patient cases for learning about radiology, etc.). Everyday problems are used to increase the likelihood that learners will readily identify how concepts can be *applied* in a given setting. Complex contexts are used as a way to assist learners in thinking about the content in ways that are consonant with a community of practice. It is not likely, for instance, that scientists learn about science by reading and memorizing laws; rather, they use an inquiry-based approaches for hypothesizing and predicting outcomes based upon a collection of empirical data. OELEs strive to mirror the holistic thinking practices of experts, within boundaries accessible to novice learners.

Complex contexts provide an anchor for making sense out of discrete pieces of information. Rather than memorize or learn content in absence from an applied context, information is learned as a result of *needing to know it* in order to solve the problem. Problem-based approaches in medical schools, for instance, teach learners to use hypothesis-driven approaches -- i.e., generate hypotheses about a case to explain the data with incomplete understanding of the related knowledge base (Hmelo, Gotterer, & Bransford, 1997). Once hypotheses are generated, data is searched and selected that confirm, formalize, and/or refute the hypothesis. Consequently, new data or information becomes meaningful as its potential for *use* is evaluated in light of a driving context and hypothesis. OELEs use complex, meaningful contexts to assist learners in building formative theories and to then search for new information to confirm, elaborate, or refute the hypothesis.

Provision of Tools and Resources

OELEs use tools and resources to assist learners in accessing both sources and perspectives related to the content under study. Often, a range of resources are provided that serve as repositories of information (e.g., CD-ROMs, encyclopedias) that can be brought to bear to solve a particular problem. For instance, problem-based approaches for medical school training may incorporate databases of resources such as patient X-Rays, disease diagnosis references, or patient histories. Students using a microworld on physics concepts may access resources about formal concepts such Newton's Laws, or a database of student perspectives regarding how the concepts manifest in everyday life (e.g., hitting a baseball; riding a bicycle; slowing down in a car, etc.).

Environments can also be designed to facilitate the *construction* of resources by learners. For instance, students can learn about fractions by designing and constructing educational software for teaching younger children about fractions (Harel & Papert, 1991). Similarly, tools such as *Intermedia* utilize a networked multimedia system

where learners construct a "web" of concepts, and share them communally with other students. The use of resources, or opportunities to construct resources, provides a rich environment for extending understanding.

Tools for constructing and manipulating understanding are used to promote learning that is more concrete and capable of being tested. Tools, such as spreadsheets or word processors, provide opportunities for user-centered activity. In learning environments, tools help learners to manipulate features and processes. Some tools, such as those found in simulations and microworlds, allow learners to manipulate concepts by varying parameters and/or physical models (e.g., vary force and direction of an object in space, [Rieber, 1992]). Computerized tools can be used to select text for electronic notebooks, create hyperlinks between sources of information, or perform calculations (Hannafin, 1992). Tools allow learners to test complex theoretical concepts in concrete ways (Hannafin et al., 1994).

Learner Reflection and Self-Monitoring

The student-centered learning process hinges upon the learner's ability to monitor learning needs and to place into action planning and evaluation approaches. OELEs typically emphasize activities that induce and facilitate reflection on the learning process. The CSILE environment, for instance, is designed to facilitate metacognitive thinking through the use of prompts to generate questions, hypotheses, or theories (Scardamalia et al., 1989). Other environments facilitate reflection of scientific inquiry or critical thinking skills by embedding activities that induce connection of hypotheses to observations (Lewis, Stern, & Linn, 1993). By virtue of their design, OELEs require complex thinking skills and a variety of strategic and evaluative processes. For this reason, OELEs guide learners in using these techniques by embedding the reflective requirements of the activity into the environment itself.

OELEs often require the creation of end-products that make learner reasoning overt. It is not enough, for instance, for a learner to simply manipulate variables in a microworld or develop hypotheses without understanding *why* they are relevant. Instead, OELEs require learners to communicate what they have learned through the development of "artifacts" that reflect both the product of their understanding and/or underlying argumentation. Project-based approaches, for instance, often revolve around the creation of learner-generated multimedia products. Thus, a preservice teacher learning how to incorporate technology into the curriculum, might develop an example lesson indicating how they would use technology in the classroom. Accompanying this product might also be documentation regarding how it solves an identified problem and how technology is an instrumental part of the solution. Consequently, reflective activity is supported through both en-route and end-product requirements of the activity. En-route reflection is necessary for learners to ask driving questions, identify "needs-to-know," and implement strategic plans during the open-ended learning process. End-product reflection is necessary to justify or argue what has been constructed.

Social, Material, or Technological Scaffolding

OELEs rely on the learner to direct the learning process, formulate goals, and interpret events within the environment. Social, material, or technological support is also provided to assist learners in the knowledge construction process. Many OELEs, for instance, utilize teacher-student and student-student interactions to model or scaffold reflection and performance (Hannafin & Land, 1997; Palincsar & Brown, 1984; Scardamalia & Bereiter, 1985). In such environments, teachers and students coach, model, and share strategies within a problem context (Collins, Brown, & Newman, 1989). Learners contribute to continually evolving archives of knowledge that are shared and used as the basis for evaluating individual understanding (Scardamalia et al., 1989). Such scaffolding emphasizes the sharing of sense-making processes and the progressive negotiation of meaning.

Technology is also used as a way of scaffolding performance. Technology-based environments often "...provide models, opportunity for higher level thinking, and metacognitive guidance... in a learner's zone of proximal development" (Salomon, Globerson, & Guterman, 1989, p. 620). That is, technology is used in ways to support understanding that would be difficult, if not impossible, to support otherwise. For instance, visualization tools used in microworlds such as *Geometer's Sketchpad* and *Interactive Physics* allow learners to construct models or objects and rotate and manipulate them in order to test their parameters. Technological tools can scaffold opportunities for learning by altering both the experiences available to learners and the cognitive requirements of the learning task (Salomon, 1986).

Assumptions and Issues Associated with the Design of OELEs

A variety of isolated case studies of OELEs have been detailed that discuss the design and development considerations specific to the given environment (see for example, Cognition and Technology Group at Vanderbilt, 1992; Rieber, 1992; Lewis et al., 1993). Research on these environments has been promising, but often detail the seemingly unique requirements and features of a particular environment. General design guidelines and heuristics have occasionally been offered, but little has been done to synthesize the common features and assumptions underlying these environments, nor to present a unified theory of design. Consequently, apart from isolated conceptions of OELEs, little is understood regarding how to design learner-centered environments that cross content areas and specific uses of technology (Hannafin & Land, 1997).

The concept underlying OELEs, however, is not limited to solely one kind of technology-based environments. Rather, OELEs comprise many forms, often with few discernible similarities. This makes it difficult to identify common characteristics to use as the basis for design. This section, then, will discuss common assumptions that are manifested across diverse environments.

Assumption One: Understanding is best achieved when situated in relevant contexts.

One assumption underlying use of OELEs is that knowledge, context, and process are inextricably tied (Brown, Collins, & Duguid, 1988). This implies that learning of discrete information, decontextualized from its application, will remain "inert" (Whitehead, 1929) or unable to be used. Rather than isolating information, OELEs embed relevant knowledge within problem contexts. Thus, learning of specific information takes place as a consequence of needing to know it and apply it to solve the current problem. *Science Vision* (Tobin & Dawson, 1992), for instance, immerses students in learning science concepts through use of an authentic context. Students learn about force and motion concepts, for instance, by using them to build a virtual roller coaster. They learn chemistry concepts by resolving problems related to a polluted river. Information that is anchored in relevant and situated contexts is viewed as integral to learning how and why information is meaningful.

Furthermore, situating knowledge within realistic practices requires learners to model the processes that they may ultimately practice. That is, the *process* required to apply information to solve problems is consonant with the manner in which experts or practitioners use them. In this sense, the process of learning is not disconnected from the process by which knowledge and skills will be ultimately used. Preservice teachers, for instance, typically take courses on learning how to integrate technology into the curriculum. An authentic context for learning these types of skills would incorporate learning of the technology *with* learning how to apply it in the classroom. Yet, it is more typical that they learn the discrete "how to's" of using technology, without learning how to *think* about conceptualizing technology-based learning experiences. Using situated contexts helps to assure that knowledge is not separated from either the process or context of applying it.

Assumption Two: Learners must take more responsibility for monitoring, and reflecting upon, the learning process.

OELEs assume that learners have the metacognitive awareness to take direction of the planning, implementing, and evaluation process. Through guidance from the system, learners are provided with hints, orienting scenarios, help options, and direct instruction if needed. Presumably, with more opportunities to make choices regarding what, when, and how to learn, learners evolve greater responsibility for their learning. Evidence also suggests that learners are becoming increasingly compliant in their thinking -- seeing the learning task as one of matching their ideas and theories of an external agent (typically a teacher) (McCaslin & Good, 1992). For these reasons, OELEs provide learners with opportunities to derive and test individual sense-making processes.

To be effective during open-ended learning, learners must monitor their thoughts and actions. Learners interact based upon metacognitive awareness of their understanding and the perceived need to validate or challenge their understanding (Perkins, 1993). This includes decisions to pursue additional practice, search for definitions or information, test a hypothesis, create a "what if" scenario, or take notes. Learners must be able to locate, select, organize, integrate, and use relevant information if they are to generate products and/or understanding. Similarly, learners must evaluate the adequacy of their approaches during open-ended learning (Belmont, 1989). Learners are assumed capable of meeting these metacognitive requirements *if* they are supported by system-learner, teacher-learner and learner-learner interactions.

Assumption Three: Understanding is best supported when learners connect personal experiences with formal concepts.

One assumption of OELEs is that personal beliefs, experiences, and conceptual schemata support current, as well as provide the foundation for new, understanding (Hannafin, 1992). Background knowledge and experience form the conceptual referent within which new encounters are organized and assimilated (Piaget, 1976). Background context influences the choices learners make in the environment, the extent to which they persevere, and the types of goals they set. Accordingly, learner use of prior experiences as a referent for understanding is foundational to the design and development of OELEs.

OELEs often utilize problem contexts that are accessible to learners' everyday experiences. Rather than present information in the abstract, it is presented within rich, concrete experiences that can be manipulated, compared, and explored. By allowing learners to have concrete experiences with phenomena, they are given the opportunity to reshape ongoing theories that are based upon personal experiences. For instance, the *ErgoMotion* environment supports learners in the development a virtual roller coaster, in order to explore basic mechanics principles. It is assumed that learners will utilize their experiences in riding roller coasters as the basis for making decisions and making sense out of the events in the environment. As learners connect system experiences with prior experiences, they access existing frameworks to be build upon. This knowledge can then be used to enrich or elaborate the formal concepts under study, as they are integrated into prior experiences. It is commonly believed that integrating new knowledge with existing conceptions results in more meaningful learning (Mayer, 1984).

Assumption Four: Learning is a byproduct of progressive negotiation and interpretation of meanings.

OELEs support personal theory-building through opportunities to generate, test, and revise ongoing theories-in-action (Land & Hannafin, 1996). It is assumed that learners hold initial, although often incomplete or naive beliefs, that are progressively refined through interaction with the environment. These beliefs form the foundation for understanding and establish assumptions that can be tested while engaging the system, teacher, or other students. Microworlds and simulations, for instance, allow learners to generate and test "working models" of their understanding. By varying parameters and hypothesizing their outcomes, learners test assumptions and revise thinking based on observations.

OELEs are designed to assist the leaner in the process of *angling*, or considering multiple perspectives, during the learning process. Multiple perspectives from teachers, experts, or peers are coordinated to form a knowledge base from which learners evaluate multiple sources of meaning. *Bubble Dialogue* (Language Development and Hypermedia Research Group, 1992), for example, allows learners to share dialog, viewpoints, and perspectives. Similarly, the *Knowledge Integration Environment* (Linn, 1995) uses web technology to support learners in sharing databases of learner-constructed evidence for evaluating scientific phenomena. Varied methods and perspectives are viewed as critical to developing deeper, divergent, and more flexible thinking processes.

Summary

OELEs draw upon a variety of theoretical foundations and methods in their design. Yet, despite the differences among isolated approaches, most OELEs share a common set of key characteristics and assumptions. The common characteristics and assumptions can be used to leverage the effective design of these environments. What remains to be discovered are "best practices" and/or "best models" for doing so.

Theoretical Model for the Design of OELEs

Key characteristics and assumptions of OELEs, as well as our experiences in the development of OELEs, were used to guide the creation of a theoretical model for the design of OELEs. The model depicted in Figure 1 is an example of how elements within the model overlap and build upon one another. What follows is an explanation of each phase of the model. The reader is reminded that this is a theoretical model; continued exploration and use of the model for designing and developing OELEs is needed.

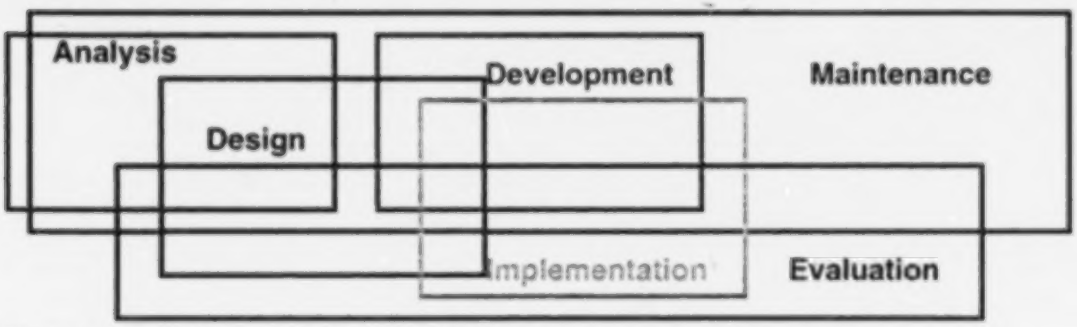

Figure 1. Theoretical model for the design of OELEs.

Analysis

The analysis phase leads the way in the design of OELEs, as it does in most instructional design models (Dick & Carey, 1997; Kemp, Morrison & Ross, 1998; Smith & Ragan, 1993; West, Farmer & Wolff, 1991). Analysis in OELE design places the designer in the role of sleuth, seeking to discover information about the environment in which the OELE will be implemented (face-to-face or other) and the participants in the OELE, including the learners and the instructor. OELE analysis also involves the exploration of the task, both from the learner's and educator's perspectives.

Environmental analysis. Environmental analysis is a sub-process in the analysis phase. As defined by Tessmer (1991), environmental analysis involves "...the analysis of the context in which the instructional product will be employed, of the physical and use factors of the instructional environment, and its support environment (p. 9). The goal in environmental analysis is to describe *where* the product will be used, *how* it will be *used*, and *how* it will be *sustained* in its use. Several areas are explored during environmental analysis.

1. *The driving factors behind the creation of the OELE.* For example, one question asked during the environmental analysis is "why is the instruction important? In asking this question, the designer seeks to provide a societal context for the OELE (West, Farmer & Wolff, 1991). Examples of why the instruction may be important include: economic forces (e.g., need for more knowledge workers; need for learners with a higher degree of cognitive strategies), social (e.g., need for stronger interpersonal skills), and physical (e.g., need for greater eye-hand coordination skills).
2. *The viewpoint taken in the creation of the OELE.* West, Farmer & Wolff (1991) discuss three viewpoints: functionalist, conflict, and critical. Of the three, a critical viewpoint is more aligned with the characteristics and assumptions of OELEs. A *critical* viewpoint involves an emphasis on "...the need for individuals to be critically aware of the choices they make and their implications" (p. 224) [see West, Farmer & Wolff (1991) for a more thorough discussion of the viewpoints]. Creating an environment where learners drive what occurs and also take on an acceptance of this responsibility, it a key characteristic in OELE design. It is important to note that the educator, or learner, may come to the OELE with another viewpoint toward learning (e.g., functionalist or conflict). To become fully immersed in an OELE, it is important to evaluate viewpoint, and work toward a more critical orientation.
3. *The structure of the learning environment.* The structure of the OELE determines the degree of definition (well-defined or ill-defined) given to the problems presented/created in the OELE. Spread across a continuum, the problems in an OELE typically range from moderately defined to ill-defined [see Jonassen (1997) for a thorough discussion of problem states]. Determining how much structure will be a part of the OELE will establish a foundation for the continued development of the OELE.
4. *The purpose in creating the OELE.* In creating a purpose, the designer of the OELE defines several fundamental elements in the design process. These include:
    - the problem being solved by the OELE (e.g., lack of transfer to novel situations; little opportunities for problem-solving; lack of argumentation from multiple perspectives, etc.).
    - the goal (both in terms of content and processes) of the OELE (e.g., argue a position using formal and informal sources of evidence; engage the scientific inquiry process, etc.)

- the type of learning the goal exhibits (ala, Gagne's (1972) type of learning outcome); and
- the function of the OELE (i.e., why do the learners need to know what is being learned).

Participants: Their Role and Characteristics. The next sub-phase in analysis involves getting to know the participants who will be taking part in the OELE. This phase in the design process also involves role and characteristic identification for the various participants (e.g., educators, learners and external experts) (West, Farmer, & Wolff, 1991). Participant analysis can be divided into several steps.

1. *Identification of who will be participating in the OELE.* Depending on the development of the OELE, the learner alone may be engaged in the learning environment. Independent study courses provide one example of how an OELE may be created with only learner participation.

Both the learner and the educator may be engaged in the OELE. While this may be considered a more "traditional" orientation to how learning occurs, the roles that the learner and educator play in an OELE are different than those traditionally played in learning context. Defining the roles played is a critical step in OELE design and is discussed in the next section.

A final consideration in terms of OELE participant identification relates to external experts. In making the decision related to the inclusion of external experts, the OELE designer seeks to answer a two-part question: will external experts play a part in the OELE, and, if so, in what capacity and how much?

2. *What role will be played by the participants in the OELE.* Making decisions regarding who will take part in the OELE are important. However, defining their roles hits at the crux of a primary assumption of OELEs: the learner taking on a greater sense of responsibility for their learning.

The roles played by those participating in the OELE are manifested in various ways. It should be noted that while it is important to define roles in the analysis phase, participant roles can, and often do, change during implementation of the OELE. One element that may drive the need for redefinition of roles is the comfort level of both the learner and educator in working in an OELE. The experience level of the learner and educator in engaging in OELEs may also affect role definition.

Three potential scenarios can be drawn related to role definition.

- *Scenario 1: The learner has almost all of the control in the OELE.* This control may include (but is not limited to) setting goals, selecting resources, and defining problems to be solved. In this scenario, the learner is very much engaged in self-directed learning.
- *Scenario 2: The learner and the educator play somewhat equal roles in the OELE.* In this instance, the educator may have some goals/objectives they consider essential for the learner to achieve as they engage in the OELE. The educator may also have pre-selected some (perhaps all) of the resources to be used in the OELE. However, the learner may have a voice in determining how or when these goals/objectives are achieved, as well as some of the resources they select for achieving those goals/objectives.
- *Scenario 3: The learner takes more of a leading role, while the educator plays a support role in the OELE (i.e., socially scaffolded learning environment).* In this instance, the educator acts as a foundation builder for the learner's engagement in the OELE. The educator works in setting the stage, bringing in the various props (i.e., resources), and creating an overall atmosphere for the OELE. The learner then acts as the driving force in what, how and when things occur within the OELE. In a face-to-face environment, this may mean that the educator establishes a structure via a syllabus, recommended readings, suggested projects, and scheduled external expert seminars. The learner then makes decisions regarding what problems to solve, and how and when to solve them.

3. *Relevant characteristics of participants.* The final element in participant analysis involves the discovery of participant characteristics which may impact their involvement in the OELE. Particular areas to attend:

- the learners prior experiences both in terms of the concepts being learned and the process being engaged in the OELE;
- learner misconceptions that may underlie learning of the concepts; and
- the educator's prior experience with the kinds of conceptual and procedural shortcomings learners experience in OELEs.

Design

Design begins after analysis has been initiated, but does not wait until it is "finished." In OELEs, an orientation toward rapid design is adopted. This is similar to the rapid prototyping model proposed by Tripp and

Bichelmeyer (1990). According to Tripp & Bichelmeyer, rapid prototyping involves the overlapping of various steps or phases in the instructional design process [see Figure 1 for an example of how this is manifested in OELE design]. This aligns the designer with the learners and educators who will be engaged in the OELE: in a problem-solving, critical thinking orientation.

The design phase in the creation of an OELE engages the designer in creating a framework for the learning environment. As in most other design models (Dick & Carey, 1997; Kemp, Morrison & Ross, 1998; Smith & Ragan, 1993; West, Farmer & Wolff, 1991), the OELE designer explores the creation of objectives or goals, helps define instructional content, and engages in strategy specification.

Defining objectives. The participant roles defined in the analysis phases will have direct implications for how (*if*) objectives are defined by the designer or by the learner. In certain implementations of OELEs, the designer may establish overarching objectives for the environment, upon which the learner elaborates, adapting them to their particular context and/or needs. This recognizes the fact that not *all* objectives or goals can be determined in OELEs a priori. Yet, the designer is typically responding to some needs or problems identified in the analysis phase. These goals and objectives may be broader than or different in scope from traditional behavioral objectives. But, typically, the designer is considering a collection of overarching goals regarding skills, processes, or strategies that are desired. In other implementations, the learner derives their own objectives based on what they hope to achieve. In either instance, the defining of the objectives usually occurs within the design phase -- either at the beginning (if established by the designer) or toward the end (if established by the learner when the OELE is implemented) of the process.

Instructional domains. The instructional domains component of the design process refers to determining the type of learning outcome(s) the learner will engage in the OELE (Gagne, 1972). Instructional designers have used a variety of taxonomies to determine the type of learning upon which the goal/objective focuses. These include: Bloom's taxonomy of cognitive outcomes (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956), a taxonomy of affective outcomes (Krathwohl, Bloom, & Masia, 1964), Simpson's plan for a taxonomy of psychomotor outcomes (Simpson, 1966-67) and Gagne's (1972) taxonomy of learning outcomes [note: see Driscoll (1994) for a more comprehensive discussion of each taxonomy]. Gagne's (1972) taxonomy is the most comprehensive, and establishes five categories of learning outcomes: verbal information, intellectual skills, cognitive strategies, attitude, and motor skills. Establishing the type of learning outcome in relation to the goal will assist the OELE designer in creating a foundation for guiding the selection of strategies later in the design process.

Instructional content. When determining the instructional content, the designer may encounter pre-determined expectations related to the learning environment. In this instance, it may become a matter of elaborating upon or refining what has been covered in the learning environment in prior implementations. This part of the design phase is important as it enables the designer to focus later efforts, especially in terms of development. It should be noted that like the establishment of objectives, who determines the instructional content is very dependent upon the roles established in analysis.

Means of instruction. Means of instruction relates to the instructional strategies and media employed in the OELE (West, Farmer, & Wolff, 1991). This sub-component of the design phase can be broken-down into three subsequent areas.

1. *How the content/processes are best taught/learned.* Traditionally, instructional designers have looked to specific strategies based on learning outcome to guide how to teach/assist learners in learning content and processes. As stated by Jonassen (1997), "...the most pervasive assumption of instructional design is that different learning outcomes necessitate different conditions of learning (Gagne, 1966)" (p. 66). Books have been written devoted to the topic of instructional strategies (see, for example, Gagne, 1985; Gagne & Medskar, 1996; Leshin, Pollock, & Reigeluth, 1992) and software programs have been developed to assist designers in creating instruction based on specific outcomes and strategies (see, for example, *Designer's Edge*).

   Given the emphasis on problem-solving and critical thinking in OELEs, how the content/processes are best taught/learned takes on an additional level of challenge when the environment is open-ended in its orientation. "Because problem-solving outcomes are not sufficiently acknowledged or articulated in the instructional-design literature, little advice about how to design problem-solving instruction is available" (Jonassen, 1997). Jonassen (1997) has proposed two instructional design models for the design of well-structured and ill-structured problems. His ill-structured problems instructional design model holds particular promise for OELEs; however, this is an area in need of further research and exploration.

2. *How to best teach/learn cognitive strategies.* The development of cognitive strategies is a critical process in OELEs. Assisting and encouraging learners in the development and refinement of cognitive strategies should be a critical part of what occurs in an OELE. This is an instructional strategy area which has been developed by Gagne' (1985). Following the basic tenets of his specified conditions for learning can greatly assist the learner as they engage in an OELE. As summarized by Driscoll (1994), these conditions include:

- describe or demonstrate the strategy;
- provide a variety of occasions for practice using the strategy; and
- provide informative feedback as to the creativity or originality of the strategy or outcome (p. 345).

3. *Selection of the delivery media.* In an OELE, the delivery media are often many and varied. Ranging from books, to people, to on-line databases, an underlying assumption in OELEs is the provision of multiple resources to help facilitate the development of multiple perspectives.

Media should not only vary in terms of the physical mode, but the content delivered via the media should also vary. This will also help facilitate the creation of multiple perspectives as the learner seeks to make meaning and establish understanding.

Evaluation methods. Evaluation is represented as an underlying process in the model depicted in Figure 1. The selection of evaluation methods as a part of the design process focuses on assessment methodologies for the instruction, as well as learner achievement. As with other components discussed in the design phase, evaluation methods are dependent upon the participant roles defined in the analysis phase of the instructional design process. If the learner is taking a lead role in the environment, evaluation may be focused solely upon self-critique measures. If the learner and educator are working on equal terms in the OELE, evaluation methods may be determined by both parties.

A critical assumption in an OELE involves learner engagement in self-monitoring and reflection as a part of involvement in the environment. This should be taken into consideration when creating evaluation methods.

Development and Implementation

The development phase, like the design phase, overlaps with several other areas in the design process, including design and implementation. As depicted in Figure 1, development and implementation almost work "hand-in-hand" in terms of creating the OELE. This overlap makes it logical to link these two phases of the process together in discussion. The ways in which the model is depicted also reflects essential element in OELE design: development is on-going, almost throughout the duration of the course.

Development and implementation place the designer in "doing" mode. At this point in the design of the OELE, the designer focuses on the creation of the various resources, and potentially tools, that the learner will need to fully engage the environment. Special considerations are discussed below.

Resources. Resources are a critical component in OELEs. In many instances, they serve as the stepping stones for the building of understanding (Hannafin et al., 1994). As such, OELE resources are not limited in terms of either their format or function. OELE resources may include people such as the educator, fellow learners, or external experts. Other resources utilized in an OELE may be electronically mediated in some fashion (e.g., video, Web sites, sound files) or be print-based in their orientation (e.g., books, journal articles, pamphlets). Still other OELE resources may be external agencies which store vast amount of information, such as academic or public libraries.

The function of OELE resources is just as varied as the formats in which they are delivered. The resources (whether selected by the learner or the educator) may serve to displace myths related to a particular topic. OELE resources may also act as factual information providers. Depending upon how it is used, the resource may also provide an incentive for the learner to look at an issue/topic from an orientation they never considered.

While providing resources in a variety of formats is an important consideration in OELEs, taking into account the message being conveyed by the resource as they are used within the implementation of the OELE is also critical. In seeking to expand the learner's orientation to multiple perspectives (a key characteristic of OELEs), OELEs demand that the resources selected represent varied orientations. While varied, they must also be "bound" together functionally in the environment in ways that converge upon a theme, yet diverge to support unique purposes and goals.

Another critical component of OELE resources relates to the actual creation of the resources. OELE resources are not limited to those which are developed in-house. Perhaps one of the biggest challenges associated with the design of OELEs comes in the gathering of the resources for the environment. While in some instances this may involve first-hand creation, often it involves seeking and gathering the resources into a readily accessible space so multiple learners have ready access to the necessary information.

On-going effort. A second element in the development and implementation phases, on-going effort, serves to illustrate the strong tie between the two areas. Certainly, implementation is an on-going effort throughout the life of the OELE. However, development work can be, and often is, an on-going effort. The types of resources needed will likely change as the problems posed by either the educator or learner emerge and grow. Continuous examination and evaluation of the resource-base is essential for assisting learners in their evolving understanding.

Evaluation

Evaluation is the process used to provide feedback to designers, enabling continual improvement of the OELE (Kemp, Morrison, & Ross, 1998). In an OELE, evaluation is a continuous process. Starting during the analysis phase of OELE design, evaluation underlies all other phases and processes associated with the creation of an OELE. Perhaps what is more critical is that the evaluation is engaged by all participants in the OELE, and in a variety of ways.

The designer engages in evaluation as a self-check to ensure that they have considered all aspects in the creation of the OELE, and to measure effectiveness of instruction, as well as the learning environment itself. The learner engages in self-evaluation and re-assessment throughout their involvement in the OELE. By cutting across the design process, the evaluation phase brings together a variety of audiences and perspectives, strengthening the further enhancement of the OELE.

Maintenance

Maintenance involves the continual upkeep of the OELE. Tessmer (1991) refers to this as sustaining use, and recommends that strategies for maintenance begin during the analysis phase. Maintenance is much like evaluation -- a continuous process throughout the life of the OELE (see Figure 1). While often discussed in terms of the long-term implementation of an OELE, maintenance could also be viewed as a process much like evaluation: ever-present and pervasive in OELE design.

OELEs are intensive yet delicate environments. As such, like the prized orchid, they require continual monitoring and care. During implementation, for instance, the instructor must be able to discern if the learner needs additional scaffolding, is running into "dead ends," or is using incompatible approaches or strategies. The learner holds primary responsibility for the learning process; yet the instructor or designer is also responsible for creating a "space" for problem-solving to occur. Through continual monitoring, the OELE can sustain growth in understanding.

Guidelines for Using the OELE Design Model

The model discussed in the previous section was generated based on key characteristics and assumptions of OELEs, as well as our work in the development of OELEs. The model does not yet have a strong empirical foundation to support it, however, it has proven to be an effective model for us in the design of our own OELEs. As caveats, we offer the following guidelines for use of the model:

- The model is descriptive in nature. It was not created to prescribe specific steps for the design of OELEs.
- The model has been used for the development of courses following the theoretical foundation of open-ended learning.
- While the model has been informally tested in face-to-face and distance formats, other OELE implementations remain unexplored.

Conclusions and Implications

The proposed model for the design of OELE courses is extensive in scope, but far from conclusive. The model discussed in this paper is based on our own experiences in the creation of OELE courses, both in face-to-face and distance formats. There exists the probability that many elements critical to the design of OELEs have been overlooked in the discussion. What is clear is that more empirical work is needed to understand if the proposed

model is an accurate reflection of how to effectively and efficiently design OELEs. However, the model does provide a starting point for further exploration and discussion.

References

Belmont, J. (1989). Cognitive strategies and strategic learning. *American Psychologist, 37*, 122-147.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives, handbook I: Cognitive domain*. New York: McKay.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-41.

Cognition and Technology Group at Vanderbilt. (1992). The Jasper experiment: An exploration of issues in learning and instructional design. *Educational Technology Research & Development, 40* (1), 65-80.

Collins, A., Brown, J. S., & Newman, S. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning and instruction* (pp. 453-494). Hillsdale, NJ: Lawrence Erlbaum.

Dick, W., & Carey, L. (1997). *The systematic design of instruction* (4th ed.). New York: Harper Collins.

Driscoll, M. P. (1994). *Psychology of learning for instruction*. Boston: Allyn & Bacon.

Gagne, R. M. (1972). Domains of learning. *Interchange, 3*, 1-8.

Gagne, R. M. (1985). *The conditions of learning* (4th ed.). New York: Holt, Rinehart & Winston.

Gagne, R. M., & Medskar, K. L. (1996). *The conditions of learning: Training applications*. Orlando, FL: Harcourt Brace.

Hannafin, M. J. (1992). Emerging technologies, ISD, and learning environments: Critical perspectives. *Educational Technology Research and Development, 40*(1), 49-63.

Hannafin, M.J., Hall, C., Land, S.M., & Hill, J.R. (1994). Learning in open-ended environments: Assumptions, methods, and implications. *Educational Technology, 34*(8), 48-55.

Hannafin, M. J., Hill, J. R., & Land, S. M. (1997). Student-centered learning and interactive multimedia: Status, issues, and implications. *Contemporary Education, 68*(2), 94-99.

Hannafin, M. J., & Land, S. M. (1997). The foundations and assumptions of technology-enhanced student-centered learning environments. *Instructional Science, 25*(3), 167-203.

Harel, I., & Papert, S. (1991). Software design as a learning environment. In I. Harel & S. Papert (Eds.), *Constructionism* (pp. 41-84). Norwood, NJ: Ablex.

Hmelo, C. E., Gotterer, G. S., & Bransford, J. D. (1997). A theory-driven approach to assessing the cognitive effects of PBL. *Instructional science, 25*(6), 387.

Jonassen, D. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology Research & Development, 39*, 5-14.

Jonassen, D. H. (1997). Instructional design models for well-structured and will-structured problem-solving learning outcomes. *Educational Technology Research & Development, 45*(1), 65-94.

Kemp, J. E., Morrison, G. R., & Ross, S. M. (1998). *Designing effective instruction* (2nd ed.). Upper Saddle River, NJ: Merrill.

Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1964). *Taxonomy of educational objectives, handbook II: Affective domain*. New York: McKay.

Land, S. M., & Hannafin, M. J. (1996). A conceptual framework for the development of theories-in-action with open-ended learning environments *Educational Technology Research & Development, 44* (3), 37-53.

Land, S. M., & Hill, J. R. (1997). Open-ended learning environments (OELEs): A framework for design and development. In M. Simonson (Ed.), *19th annual proceedings for the national convention of the Association for Educational Communications and Technology* (pp. 181-188). Ames, IA: Iowa State University.

Language Development and Hypermedia Research Group. (1992). Bubble Dialogue: A new tool for instruction and assessment. *Educational Technology Research & Development, 40*(2), 59-67.

Leshin, C. B., Pollock, J., & Reigeluth, C. M. (1992). *Instructional design strategies and tactics*. Englewood Cliffs, NJ: Educational Technology.

Lewis, E., Stern, J., & Linn, M. (1993). The effect of computer simulations on introductory thermodynamics understanding. *Educational Technology, 28*(11), 8-12.

Linn, M. (1995). Designing computer learning environments for engineering and computer science: The Scaffolded Knowledge Integration Framework. *Journal of Science Education and Technology, 4*(2), 103-126.

Mayer, R. E. (1984). Aids to text comprehension. *Educational Psychologist, 19*, 30-42.

McCaslin, M., & Good, T. (1992). Compliant cognition: The misalliance of management and instructional goals in current school reform. *Educational Researcher, 21*(3), 4-17.

Moore, M. G., & Kearsley, G. (1996). *Distance education: A systems view*. Belmont, CA: Wadsworth.

Norman, D. (1988). *The psychology of everyday things*. New York: Basic.

Palincsar, A., & Brown, A. (1984). Reciprocal teaching of comprehension-fostering and monitoring activities. *Cognition and Instruction, 1*(2), 117-175.

Papert, S. (1993). *The children's machine: Rethinking school in the age of the computer* . New York: Basic Books.

Perkins, D. (1993). Person-plus: A distributed view of thinking and learning. In G. Salomon's (Ed.), *Distributed intelligence* (pp. 89-109). New York: Cambridge.

Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher, 24*(7), 5-12.

Piaget, J. (1976). *The grasp of consciousness*. Cambridge, MA: Harvard University.

Rieber, L. P. (1992). Computer-based microworlds: A bridge between constructivism and direct instruction. *Educational Technology Research & Development, 40*(1), 93-106.

Salomon, G. (1986). Information technologies: What you see is not (always) what you get. *Educational Psychologist, 20*, 207-216.

Salomon, G., Globerson, T., & Guterman, E. (1989). The computer as a zone of proximal development: Internalizing reading-related metacognitions from a reading partner. *Journal of Educational Psychology, 81*(4), 620-627.

Scardamalia, M., Bereiter, C., McLean, R., Swallow, J., & Woodruff, E. (1989). Computer-supported intentional learning environments. *Journal of Educational Computing Research, 5*, 51-68.

Scardamalia, M., & Bereiter, C. (1985). Fostering the development of self-regulation in children's knowledge processing. In S. F. Chipman, J. W. Segal, & R. Glaser (Eds.), *Thinking and learning skills: Research and open questions* (pp. 563-577). Hillsdale, NJ: Lawrence Erlbaum.

Simpson, E. J. (1966-67). The classification of educational objectives, psychomotor domain. *Illinois Teacher of Home Economics, 10*, 110-144.

Smith, P., & Ragan, T. (1993). *Instructional design*. New York: Macmillan.

Tessmer, M. (1991, January). Back to the future: The environment analysis state of front end analysis. *Performance and Instruction*, 9-12.

Tobin, K. & Dawson, G. (1992). Constraints to curriculum reform: Teachers and the myths of schooling. *Educational Technology Research & Development, 40*(1), 81-92.

Tripp, S. D., & Bichelmeyer, B. (1990). Rapid prototyping: An alternative instructional design strategy. *Educational Technology Research & Development, 38*(1), 31-44.

West, C. K., Farmer, J. A., & Wolff, P. M. (1991). *Instructional design: Implications from cognitive science*. Englewood Cliffs, NJ: Prentice Hall.

Whitehead, A.N (1929). *The aims of education*. New York: MacMillan.

Willis, B. (1993). *Distance education: A practical guide*. Englewood Cliffs, NJ: Educational Technology.